Implementation of Head and Finger Movement Based Automatic Wheel Chair

S. Tameemsultana and N. Kali Saranya

Abstract---*An automated system is to be developed to control the motor rotation of wheel chair based on head and finger movement of physically challenged person. In order to facilitate these people for their independent movement, an accelerometer device is fitted on persons head and a flex sensor is fixed in a glove which is to be wear by the person. Based on the head and finger movements the accelerometer and the flex sensor will drive the motor fitted to the wheel chair. The wheel chair can be driven in any of the four directions. The automated wheelchair is based on simple electronic control system and the mechanical arrangement that is controlled by a Programmable Interface Controller. This automatic wheel chair also helps people who have various other disabilities to sit on the chair and just hold the accelerometer and move it over to control the vehicle movements. In this paper the wheel chair has been mimicked using a robot.*

Keywords---*Accelerometer, Flex Sensor, Programmable Interface Controller*

I. INTRODUCTION

THE number of people, who need to move around with the help of some artificial means, whether through an illness or accident, is continuously increasing. This means have to be increasingly sophisticated, taking advantage of technology evolution, in order to increase the quality of life for these people and facilitate their integration into their working world. In this way a contribution may be made to facilitating movement and to making this increasingly simple and vigorous, so that it becomes similar to that of people who do not suffer deficiencies.

Quadriplegia or Tetraplegia[1] is a condition that occurs when a part of spinal cord inside the neck has been injured. This injury causes loss of feeling and movement in arms, legs and trunk. The damage affects the nerve fibres passes through the injured area and may impair part or all of the corresponding muscles and nerves below the injury site. Spinal injuries occur most frequently in the neck (cervical) and lower back (thoracic and lumbar) areas. A thoracic or lumbar injury can affect physiologic functions. Injury may affect breathing as well as movements of the upper and lower limbs. For Severe Quadriplegics, the only residual movement present is the head, so it is mandatory to use this movement to enhance the mobility of the patient to control the movement of the wheelchair.

The present high level of technology in electronic and robotic system permits some of the mobility problems suffered by certain people to be resolved. Electronics solves the problems very acceptably for the users. This is because the electronics used is eminently suitable for copying with the needs presented. Unfortunately more and more people are appearing with incapacities which prevent them from carrying out normal activities. Most have serious problems related to movement.

The type of artificial aid needed by a disabled person in order to move about depends, to a large extent, on the level of his incapacity. For example, in order to guide a wheel chair, various situations can be distinguished:

a) If the user is capable of controlling his head or his hands, the ideal solution is the use of a joystick.
b) Where there is a high level of incapacity, solutions are basically centered on the use of other means, such as head or finger movements.
c) Only on extreme cases it is suggested the presence of safety sensors is justified with the object of assisting the user to guide the chair (detection of obstacles, nearness to certain places the existence of stairs, etc...).

Another important requirement that a wheel chair has to fulfill is that of responding rapidly and efficiently to the commands of the user, independently of the method used for giving these commands.

This paper describes a head controlled assist system, developed using an electronic and mechanical arrangement controlled by a Programmable Interface Controller. Sensor accelerometer placed on the patient's head sensed the tilt made by the head. This tilt corresponded to the analog voltage. Using this voltage, control signals were generated for four directions of the wheelchair. Similarly flex sensor placed on person's finger will also generate signals, which is used to drive the motor.

S. Tameemsultana , Department of EEE, Amrita Vishwa Vidyapeetham, Coimbatore, India. E-mail: tameem.sultana@gmail.com
N. Kali Saranya, Department of EEE, Amrita Vishwa Vidyapeetham, Coimbatore, India. E-mail: nkalisaran30@gmail.com

II. OVERALL ARCHITECTURE

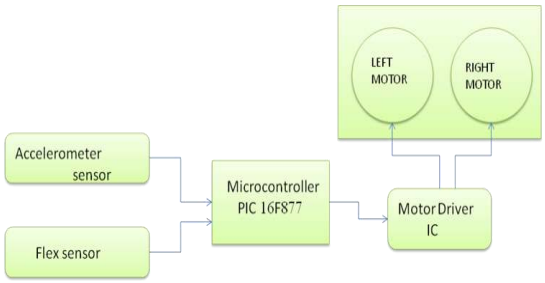

Figure 1: Block Diagram of Automated Wheelchair System

Fig 1 shows the overall structure of the assist systems that is composed of sensor design, the electronic module and the mechanical module. The sensor design comprises of accelerometer and flex sensor. The electronic module has PIC16f877 microcontroller with ADC. And the mechanical module consists of driver IC and motors.

III. FLEX SENSOR

Flex sensors are analog resistors. They are usually in the form of strip 5" long that vary in resistance. They work as variable voltage analog dividers. Inside the flex sensor are carbon resistive elements within a thin flexible substrate[6]. More carbon means less resistance. When the substrate is bent it produces a resistance output relative to bend.

A property of bend sensors worth noting is that bending the sensor at one point to a prescribed angle is not the most effective use of the sensor. As well, bending the sensor at one point to more than 90˚ may permanently damage the sensor. Instead, bend the sensor around a radius of curvature. The smaller the radius of curvature and the more the whole length of the sensor is involved in the deflection, the greater the resistance will be (which will be much greater than the resistance achieved if the sensor is fixed at one end and bent sharply to a high degree).

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A. Types of Flex Sensors

There are two types of flex sensors namely,

- Bidirectional flex sensor
- Unidirectional flex sensor

B. Bidirectional Flex Sensor

Changes resistance when bent or flexed in either direction. Resistance of sensor varies from ohms to kilo ohms. The flexible bend sensor operating temperature is -30 to 80 degree Celsius.

Figure 2: Bidirectional Flex Sensor

C. Resistance Variation in Bidirectional Flex Sensor

When the flex sensor is bent in one direction the resistance gradually increases [7]. When the sensor is bent in the other direction its resistance will decrease.

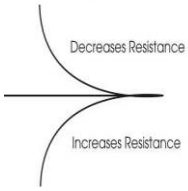

Figure 3: Resistance Variation in Bidirectional Flex Sensor

D. Unidirectional Flex Sensor

When the flex sensor is bent, the resistance gradually increases.Resistance vary between few ohms and kilo ohms [7]. The flex sensor's operating temperature is -30 to 80 degree Celsius.

Figure 4: Unidirectional Flex Sensor

E. Resistance Variation in Unidirectional Flex Sensor

Whenever the sensor is bent, the resistance either increases or decreases.

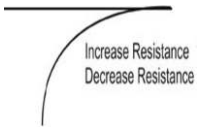

Figure 5: Resistance Variation in Unidirectional Flex Sensor

F. Basic Flex Sensor Circuit

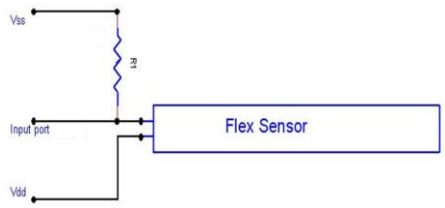

Figure 6: Basic Flex Sensor Circuit

Normally the sensor works as a part of potential divider circuit. Therefore based on flex sensor value, another resistance which is nearly equal to flex sensor value should be added in the circuit. And the midpoint of two resistors will be the voltage output. The other end of the flex sensor should be grounded.

IV. ACCELEROMETER

An accelerometer is an integrated device that measures proper acceleration, the acceleration experienced relative to freefall. Single- and multi-axis models are available to detect magnitude and direction of the acceleration as a vector quantity, and can be used to sense orientation, acceleration, vibration shock, and falling. Micro machined accelerometers are increasingly present in portable electronic devices and video game controllers, to detect the position of the device or provide for game input. It is a capable of measuring how fast the speed of object is changing. It generates analog voltage as the output which is used as an input to the control system. The accelerometer used in this automated system is MMA2260D (±1.5g axis). It is a single axis accelerometer, which senses the tilt in two directions only. The supply voltage is 5V [8]. The device is sensitive to tilt in the 0g position.

V. PIC MICROCONTROLLER

The microcontroller that has been used for this project is PIC16F877. It is an eight bit microcontroller. It has been programmed using PIC C compiler. Microcontroller contains many peripherals like ten bit ADC module, three timers, USART, SPI, Capture, compare and PWM module. Ten bit ADC is used in this project. When any analog value is given, the converter generates the digital results of the corresponding values [9]. The A/D conversion of the analog input signal results in a corresponding 10-bit digital number. It uses successive approximation type conversion. The A/D module has inputs that are software selectable to some combination of VDD and VSS.

VI. DRIVER IC

L293D is a dual H-Bridge driver, so with one IC we can interface two DC motors which can be controlled in both clockwise and counter clockwise direction and a motor with fixed direction of motion. All I/Os are used to connect four motors [10]. L293D has output current of 600mA and peak output current of 1.2A per channel. Moreover for protection of circuit from back EMF output diodes are included IC. The output supply has a wide range from 4.5V to 36V, which makes L293D a best choice for DC motor driver.

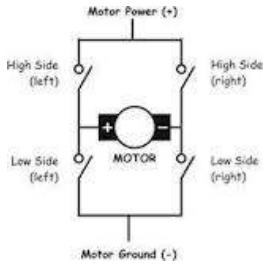

Figure 7: Driver IC

Driver IC has four switching elements within the bridge. These four elements are often called, high side left, high side right, low side right, and low side left (when traversing in clockwise order).

The switches are turned on in pairs, either high left and lower right, or lower left and high right, but never both switches on the same "side" of the bridge.

Table 1: Truth Table of L293D

TRUTH TABLE (one channel)

Input	Enable (*)	Output
H	H	H
L	H	L
H	L	Z
L	L	Z

Z = High output impedance
(*) Relative to the considered channel

VII. DESCRIPTION

The accelerometer placed on the patient's forehead measures the tilt produced by the head movement. The tilt corresponds to the analog voltage. This analog voltage will be converted into digital using PIC 16F877. Similarly the flex sensor will be placed in patient's finger. Based on the bend of finger the flex sensor will generate a resistance value. By adding suitable resistance to flex sensor circuit as voltage divider setup, the voltage will be generated, which will be an analog value to the Microcontroller. Then this analog voltage is converted to digital using ADC of PIC 16F877. Based on accelerometer and flex sensor value the controller will generate control signals, which will drive the motors fitted to robot. Thus the robot can be driven in any of the four directions.

VIII. ANALYSIS

Calibration has been done based on the output values of sensors

A. Calibration of Flex Sensor

In this automatic system two flex sensors are used. Both the sensors give output as resistance value. The resistance of first sensor varies between 175KΩ to 420KΩ and second sensor varies between 180KΩ to 450KΩ. This variation

depends upon the selection of different sensors by different manufacturers.

B. Calibration of Accelerometer Sensor

One accelerometer sensor can sense the two different tilts. Based on the ground position each tilt will generate an output as a voltage. The sensor used in this automatic system generates an output voltage which varies between 2.5V to 3.5V is given to microcontroller as an analog input. Then it converted into digital signal using ADC of controller.

IX. RESULT

When a person wears a band fixed with accelerometer and tilts his head the robot moves in corresponding direction based on the head movement.

When the person bends his finger, the robot moves in corresponding direction based on the bend of the finger.

X. CONCLUSION

As the accelerometer and flex sensor glove based automated system has been presented which would be very helpful for physically challenged persons and for the persons who cannot move their body except head and fingers. Flex sensor is calibrated to meet the potential divider arrangement. Also the accelerometer sensor is calibrated such that it produces particular analog voltage for a corresponding tilt. PIC is programmed for analog to digital conversion using PIC C compiler. As the flex sensor value was within a small range, only few combinations have been brought. A hardware set up has also been done to validate this technology.

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